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Physical and Anthropometric Profile of Youth Tunisian Elite Football Players According to Their Playing Position: A Longitudinal Study

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Abstract

Background: In elite youth soccer, the extent to which anthropometric and physical fitness parameters vary according to playing positions remains unclear. Identifying and quantifying these differences is crucial for informing targeted training interventions.

Objectives: We aimed to investigate the evolution anthropometric and physical profiles in Tunisian elite youth soccer players during one season, and to analyze differences between players according to their playing position.

Methods: Sixty-two subjects (15.3±0.2 years, 69.4±6.4 kg, 176.9±4.8 cm) playing for the top four professional football clubs in Tunisia took part in the study. They were divided into five groups according to their playing position: goalkeepers (n=10), fullbacks (n=14), central defenders (n=11), midfielders (n=15) and forwards (n=12). Various anthropometric measurements, fitness tests assessing aerobic and anaerobic performance were performed at two times (T): T1 (3 weeks after the beginning of the preparation period), and T2 (end of the competitive period).

Results: Football players across all positions exhibited significant anthropometric growth, particularly in height, with increases from small to moderate ($p < 0.001$; effect size (ES) = 0.30 to 0.57). Weight changes were non-significant ($p = 0.01$ to 0.14; ES = 0.01 to 0.14), while fat mass reductions across positions were slightly more pronounced ($p = 0.05$ to 0.25; ES = 0.09 to 0.25). Performance metrics revealed substantial improvements, particularly in the 5-Jump Test, where forwards excelled ($p < 0.001$; ES = 1.07), and in sprinting events, where consistent progress was noted across all positions ($p < 0.001$; ES = 0.16 to 0.33). The Yo-Yo Intermittent Recovery Test exhibited significant enhancements, again with forwards achieving the greatest gains ($p < 0.001$; ES = 3.01).

Conclusion: The study emphasizes the need for position-specific training in youth football, highlighting how physical and anthropometric characteristics vary by playing position. The results suggest that tailored training can enhance performance and development in young players, reinforcing the importance of customized approaches for different positions in elite youth soccer. This approach not only improves player performance but also aids in effective talent identification and injury prevention of youth soccer players.

Keywords: *Anthropometry; Adolescent; Elite; Performance; Soccer; Training.*

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1. Introduction

Football (also called soccer) is a multifactorial team sport based on technical, tactical, psychological and physical parameters (1-3). This activity requires well-developed physical fitness to be successful (2, 4). Furthermore, soccer is an intensive, multidirectional, intermittent team sport that combines distinctive intensities of activity with irregular breaks throughout a 90-minute match (5). During the 2018-2023 period, curve sprint ability has been reported as the most frequently used sprinting action in football (6, 7) and its importance has been extensively highlighted in several studies (8, 9). Optimizing the physical potential of young football players in training is a major target of the various football clubs (10).

Elite soccer players must be ready to carry out and support high training loads observed at the elite level (11). The observation and the characterization of some anthropometric and physical fitness parameters of elite youth soccer players allow distinguishing elite to non-elite based on anthropometrics (e.g., height, weight, body fat) and physical fitness parameters (e.g., maximum oxygen consumption (VO_2max), sprint performance, height jump) (12, 13). The latter observation also allows determining, at least, a reference profile according to the playing position (12, 14) or to the age category (14, 15).

Previous research has shown that elite adults have different characteristics depending on their playing position (1, 2), suggesting that goalkeepers are taller and heavier than outfield players. Furthermore, Hencken et al. (16) reported that the midfielders are the smallest and lightest outfield players, while the fullbacks are the tallest and heaviest outfield players. It should be acknowledged that physiological variations in terms of VO_2max exist among playing positions, with fullbacks and midfielders demonstrating the highest values (1, 17). In young soccer players, several studies have reported reference profile in elite young soccer players (15, 18, 19), but they failed to provide an accurate profile of young elite soccer players according to their playing positions based on anthropometric parameters and physical abilities. Indeed, within the U-16 selection of England, Reilly et al. (19) have demonstrated that there are some positional differences in anthropometry, but no differences were found in physical fitness and VO_2max(19). In a previous study, Wong et al. (14)have reported anthropometric differences between playing positions, but no differences in term of physiological characteristics in U-14 male Chinese soccer players. These results were probably due to their very low soccer training experience (< 5 years), their number of training sessions (twice a week and one match), and the duration of training and match. Slimani et al. (20) observed variations in anthropometric and physiological characteristics across different age categories and/or playing positions. From these parameters, there seems to be a difference between elite youth soccer players in China and Europe. Elite youth soccer players in Europe characterized by a higher training load (5 to 7 training sessions per week and one match), and a higher training experience (21).

In Europe, the development process of young elite soccer players is characterized by high training loads due to a high volume of training that can change the player's profile depending on the playing position (22).

While soccer is the most popular sport in North Africa, young soccer players often train under challenging conditions due to the financial constraints and the lack of facilities, except for a few clubs (23).

Unfortunately, there are few studies on the physical performance and anthropometric characteristics of the top young players in this region (24). To the best of the authors' knowledge, there is no long-term study that has examined the effects of soccer training in North Africa. Therefore, a longitudinal observational study of young North African elite soccer players, providing information on responses to elite soccer training and player profile according to playing position is warranted.

Departing from the above considerations, the main aims of this study were to ***i)*** Investigate the evolution of some anthropometric and physical fitness parameters in Tunisian elite youth soccer players during one season, and ***ii)*** To assess potential differences between young soccer players according to their playing position. We hypothesized that there are differences in anthropometric and physical fitness parameters in young elite soccer players according to their playing position. The findings of this study may contribute to the understanding of functional specialization among players based on playing positions in youth academy training programs.

2. Methods and Materials

2.1. Study design

This was a longitudinal study carried out in 2022 at the football youth academic center of Borj Cedria, Tunisia. All players underwent testing twice during the season (a period of 8 months, from September to May): once three weeks after the beginning of the preparation period (T1) and once at the end of the competitive period (T2). The rate of progression was used to assess the evolution of variables during the study. All players and their parents or guardians were fully informed and they signed a consent form (Figure 1).

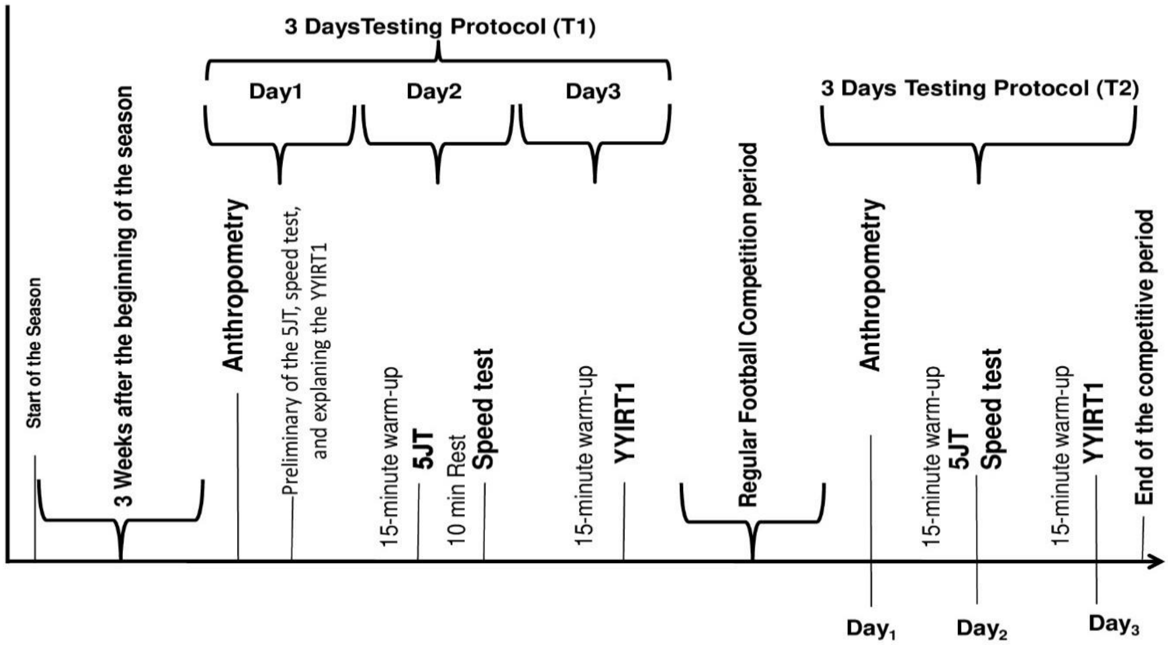

Figure 1. Study Flowchart

2.2. Participants

Sixty-two U-16 boys soccer players (15.3 ± 0.2 years) participated to this study, all belonging to the top four professional football club of Tunisia. Players performed one week-end match and practiced soccer 6-7 times/week. The players' target was to prepare for the U-17 Championship of African Nations' preliminary rounds. Players were selected as part of the national team. According to their playing positions, players were divided into five groups including goalkeepers (GK, n=10), fullbacks (FB, n=14), central defenders (CD, n=11), midfielders (MF, n=15), and forwards (FW, n=12).

2.3. Anthropometric measurements

Each player was weighted and his stature was determined at T1 and T2. To determine their body fat, skinfold measurements were taken in four sites (i.e., bicipital, tricipital, suprailiacal, subscapular) using a Harpenden skinfold caliper (British Indicators Ltd., Luton, UK). Fat body mass was calculated according to the equations previously described (25).

2.4. Puberty stage assessment

The puberty stage was the indicator of biological maturity status. It was determined and recorded by a pediatrician experienced in the assessment of secondary sex characteristics according to the method of Tanner (1975). Children at pubertal development stages 1–5 were evaluated. At the beginning of the study, according to their pubescent status, the young soccer players belonged to Tanner stage (3–4)(26).

2.5. Testing Protocol

The study protocol is represented in Figure 1. All players underwent testing on two times during the season (T1 and T2). T1 occurred three weeks after the beginning of the preparation period, while T2 occurred at the end of the competitive period. Examinations are scheduled for Days 1, 2, and 3 of each assessment period for all players. In a preliminary visit (Day 1), the following two procedures were carried out prior to the data collection from the tests: *i)* the recording of anthropometric data, and *ii)*. a demonstration of the five-jump test (5JT) procedures, a speed test, an explanation of the level 1 yo-yo intermittent recovery test (YYIRT1). 5JT and speed test were carried out on Day 2. Day 3 was set and designated for YYIRT1. All participants were tested by one experienced researcher, who utilized identical equipment, locations, and methods for every assessment in the same order. On Day 2 after a standardized 15-minute warm-up consisting of low-intensity running, followed by a series of exercises (high knee raises, hip kicks, straight jumps), followed by short bursts of acceleration, players performed two multi-test. All athletes performed the 5JT, consisting of five consecutive maximal long jumps, designed to assess lower body strength (27). Ten minutes later, players completed a 30-m sprint with a 10-m lap time as measured by an infrared optoelectronic cell (Speed trap II Wireless Timing System; Brower Timing Systems, Draper, UT). On the third day of testing (Day_3), after a standardized warm-up, players performed the YYIRT1 (28). Briefly, the test consists of two repeated 20 m round trips at increasing speeds, controlled by a calibrated CD player's audio timer. Players had a 10-second active rest period (braking and running back to the starting line) between each run. If the player missed the finish line twice or stopped voluntarily, the total distance traveled was recorded for analysis (27, 28).

Weekly training consists of six sessions, with varying content. The two days (D) following the competition (D_{+1} and D_{+2}) are dedicated to recovery through low-intensity running and stretching. After this phase of low-intensity training, the physical training content of D_{+3} and D_{+4} is mainly focused on aerobic exercise based on high-intensity interval training, small games or repeated sprints, and indoor strength training. Pre-game instructions (D_{-2} to D_{-1}) are brief, focusing on coordination and speed.

Participants' health was continuously monitored for any potential injuries, taking into consideration the load that sprint activities exert on the muscle-tendon tissue. The participants were instructed to attend the testing sessions rested and without performing any kind of strenuous activity for the previous 48 hours, wearing shorts and running shoes, and refraining from acting in any strenuous activities between the testing sessions. The study received ethical approval by the Farhat Hached Hospital (Ethical Application Ref: FHHEC21052020), and all activities were carried out in accordance with the Declaration of Helsinki and the World Medical Association's Code of Ethics.

2.6. *Statistical analyses*

The normality of the data was verified by the Kolmogorov-Smirnov test. All data were expressed as means ± standard deviation (SD). Two-way analysis of variance (ANOVA) with repeated measures was used to explore differences between the four consecutive months in the averaged data of PA physiological. The effect sizes (d) for these differences were also determined (29). Effect size values of 0.2, 0.5 and above 0.8 were considered to represent a small, moderate and large difference, respectively to estimate the meaningfulness of significant findings. According to Bland and Altman (30), intra-class correlations (ICCs) were also calculated. Statistical significance was set at $p<0.05$. All statistical analyses were conducted using the statistical package for the social sciences (SPSS, Version 18.0, SPSS Inc., Chicago, IL, USA).

3. Results

3.1. *Anthropometric and physical fitness parameters*

Anthropometric parameters are presented in Table 1. The table appears to represent the physical and performance measurements of athletes at two different time points: T1 and T2, with the accompanying effect size (ES) for the changes observed between these two periods. Height increased ($p < 0.001$; ES = 0.33, small effect). Weight, slightly decreased with minimal change (ES = 0.02, negligible effect). Fat Mass, slightly decreased (ES = 0.01, negligible effect). Distance in 5JT improved, marking a significant enhancement ($p < 0.001$; ES = 0.61, moderate effect). The time of 10 m Sprint diminished ($p < 0.001$; ES = 0.33, small effect).

The time of 30 m sprint diminished ($p < 0.001$; ES = 0.28, small effect). For YYIRT1, significant enhancement in high-intensity intermittent running capacity was showed ($p < 0.001$; ES = 1.05, large effect) (Table 1).

Table 1. Evolution of the anthropometric characteristics and physical fitness characteristics of youth soccer players during one season (mean ± SD)

	T1	T2	ES
Height (cm)	176.9 (4.8)	179.9 (4.3)**	0.33
Weight (kg)	69.4 (6.4)	69.1 (5.9)	0.02
% Fat mass	12.3 (3.2)	12.2 (2.3)	0.01
5JT (m)	11.09 (1.22)	12.24 (0.67)**	0.61
10m (s)	1.90 (0.10)	1.83 (0.11)**	0.33
30m (s)	4.51 (0.18)	4.40 (0.22)**	0.28
YYIRT1 (m)	1783 (323)	2716 (564)**	1.05

GK: goalkeepers. FB: full-backs, CD: central defenders, MF: midfielders; FW: forwards; ES: Cohen's d effect size; YYIRT1: Yo-Yo intermittent recovery test-level 1; 5JT: Five jump test; T1: beginning of the season; T2: end of the season Significant differences: *: p<0.05; **: p<0.001.

3.2. Playing positions

In a season-long study of football players, all positions demonstrated significant height increases: for goalkeepers ($p < 0.001$; ES = 0.30, small effect), central defenders ($p < 0.001$; ES = 0.33, small effect), full-backs ($p < 0.001$; ES = 0.57, moderate effect), midfielders ($p < 0.001$; ES = 0.43, moderate effect), and forwards ($p < 0.001$; ES = 0.53, moderate effect). Weight changes were less pronounced, with goalkeepers decreasing ($p = 0.14$; ES = 0.14), central defenders ($p = 0.13$; ES = 0.13), full-backs ($p = 0.05$; ES = 0.05), midfielders ($p = 0.10$; ES = 0.10), and forwards ($p = 0.01$; ES = 0.01). Fat mass reductions were also observed, with goalkeepers ($p = 0.25$; ES = 0.25), central defenders ($p = 0.15$; ES = 0.15), full-backs ($p = 0.16$; ES = 0.16), midfielders ($p = 0.09$; ES = 0.09), and forwards ($p < 0.05$; ES = 0.31, small effect). This data underscores the physical development in height and body composition football players undergo during a competitive season (Table 2).

Throughout the season, athletes demonstrated improvements in various performance metrics. In 5-JT, for: GK ($p < 0.05$; ES = 0.59, moderate effect), CD ($p < 0.001$; ES = 0.65, moderate effect), FB ($p < 0.05$; ES = 0.56, moderate effect), MF ($p < 0.05$; ES = 0.37, small effect), and FW ($p < 0.001$; ES = 1.07, large effect). Times in the 30m Sprint also saw improvements, for: GK ($p < 0.001$; ES = 0.27, small effect), CD ($p < 0.001$; ES = 0.16, small effect), FB ($p < 0.001$; ES = 0.24, small effect), MF ($p < 0.001$; ES = 0.24, small effect), and FW from 4.46 s to 4.36 s ($p < 0.001$; ES = 0.33, small effect). The YYIRT1 revealed substantial improvements; for: GK ($p < 0.001$; ES = 0.70, moderate effect), CD ($p < 0.001$; ES = 1.33, large effect), FB ($p < 0.001$; ES = 1.87, very large effect), MF ($p < 0.001$; ES = 1.74, large effect), and FW ($p < 0.001$; ES = 3.01, very large effect). These results underscore significant seasonal advancements in explosive power, speed, and high-intensity intermittent recovery capacity across all positions (Table 2).

Table 2. Anthropometrics and Physical fitness of the youth soccer players during one season, according to their playing positions

	Height (cm)			Weight (kg)			Fat mass (%)			5-JT (m)			30m Sprint (s)			YYIRT1 (m)		
	T1	T2	ES	T1	T2	ES	T1	T2	ES	T1	T2	ES	T1	T2	ES	T1	T2	ES
GK	183.3 (3.5)	185.3 (3.2) **	0.30	78.00 (5.0)	76.90 (3.3)	0.14	14.18 (1.5)	13.19 (2.4)	0.25	11.16 (1.0)	12.10 (0.6)*	0.59	4.63 (0.2)	4.52 (0.2)**	0.27	1480 (341)	1720 (0)**	0.70
DEF	176.6 (4.4)	179.4 (4.2) **	0.33	69.80 (4.6)	68.6 (4.5)	0.13	12.45 (3.6)	11.56 (2.3)	0.15	10.83 (1.4)	12.32 (0.9)**	0.65	4.49 (0.3)	4.41 (0.2)**	0.16	1733 (477)	2986 (463)**	1.33
FB	176.2 (2.9)	179.9 (3.6) **	0.57	67.30 (3.8)	67.00 (1.9)	0.05	12.38 (3.1)	10.75 (2.4)	0.16	11.12 (1.4)	12.20 (0.7)*	0.56	4.49 (0.2)	4.37 (0.3)**	0.24	1880 (284)	2860 (241)**	1.87
MF	175.3 (4.2)	178.7 (3.7) **	0.43	64.70 (4.1)	65.50 (4.2)	0.10	10.55 (3.1)	10.09 (1.9)	0.09	11.39 (1.4)	12.19 (0.8)*	0.37	4.47 (0.2)	4.35 (0.3)**	0.24	1712 (267)	2768 (339)**	1.74
FW	173.9 (3.3)	177.2 (2.9) **	0.53	68.30 (6.6)	68.4 (7.3)	0.01	12.27 (3.5)	10.57 (1.9)*	0.31	11.05 (0.8)	12.34 (0.4)**	1.07	4.46 (0.2)	4.36 (0.1)**	0.33	2040 (134)	3106 (220)**	3.01

GK: goalkeepers. FB: full-backs, DEF: central defenders, MF: midfielders; FW: forwards;YYIRT1: Yo-Yo Intermittent Recovery Test-level 1; T1: beginning of the season; T2: end of the season Significant differences: *: *p<0.05*; ** :*p<0.001*.*ES*: Cohen's d effect size.

4. Discussion

This study aimed to investigate the evolution of anthropometric and physical fitness parameters in young Tunisian elite soccer players and analyze differences based on their playing positions. The results indicate significant increases in anthropometric characteristics and physical fitness throughout the season. However, establishing an accurate reference profile based on playing position in Tunisian U-16 elite soccer players proved challenging. Regarding anthropometric data, our subjects were taller than those reported in the literature (12, 15, 31). Indeed, U-16 French and Portuguese elite soccer players were 173.5 ± 8 cm and 174 ± 4cm, respectively (15, 18). The increase in height could be explained by the biological development of this group. These young soccer players were U-16 in the year of the experiment, but Philippaerts et al. (31) pointed out that the peak height velocity was reached at about fourteen years of age. The subjects were also heavier than reported in the literature (12, 15, 31). Our data regarding percent fat mass were close to, but slightly higher than, those reported in the literature (12, 32). As shown in previous studies of young soccer players, GK is significantly taller and heavier and have a higher percentage of fat mass than field players, for whom there is no difference in measured height and weight (12, 14). However, FW had a similar percentage of fat mass as the other outfield players. In contrast, Gil et al. (12) reported that the FW had the highest muscle mass. Several studies conducted on elite adult soccer players are consistent with these current findings (1, 17). The differences in anthropometric characteristics may be attributed to genetic, social, nutritional, and cultural factors, as well as the selection process employed (33). Coaches and staff may have selected players based on anthropometric characteristics to employ specific athletic strategies during matches. Tactical considerations likely play a role in these decisions, as tactics can vary based on player profiles. Concerning physical fitness parameters, sprint performances increased significantly throughout the season. Indeed, the 5JT performance increased significantly. It is worth noting that this test was significantly correlated to the vertical high jump and explosiveness variables measured during isokinetic testing, and valid to assess training adaptations (27). In the light of this result, we can confirm that this increase is meaningful (34) with more than 10.3% of gain. In soccer, few studies have used this test, explaining the lack of values of references for this age category (5).

Chamari et al. (27) measured in U-23 Tunisian National Olympic team a performance in 5JT around 12.99 ± 0.53m whereas our elite players jump around 12.24 ± 0.67m. This proximity between these two results suggests the good development of muscular power and the effectiveness of training program in our elite young soccer players. No differences of playing positions were observed between each group in 5JT. Performance on 10 and 30m sprint increased significantly (3.7 and 2.5%, respectively) over this season. Stølen et al. (4) reported that 96% of sprint realized during a match are lower than 30m.

Only a few studies involving youth soccer players have opted for the 30 m sprint, with the more prevalent choice being the 40 m sprint (15, 35). Our data were close to those reported in the literature (36). Chamari et al. (32) reported in juniors' Tunisian and Senegalese players' slightly better performance (4.38 ± 0.18 s) than our subjects. The training focalized on velocity and coordination appears to be effective to develop the ability to sprint on at a short distance and related to analyzing the activity of elite soccer players (4). Surprisingly, we observed no positional differences on anaerobic profile. Moreover, goalkeeper's performances were similar to those of outfield players. Di Salvo et al. (36) have showed that the activity profile of elite goalkeepers were decisive during the match, especially the sprints ranged from 0 to 5 m. This observation could explain, at least in part, our findings. It also means that outfields players do not differ in their sprint characteristics whereas the activity on the pitch is not the same whatever in young (37) or in adults (36). It seems that sprint training can be more individualized in respect to the playing position as well as physical and technical activity (38). Wong et al. (14) have reported that CD were the faster in 30 m U-14 Chinese.

In this study, MF reached the best performance (4.35 ± 0.3s) on 30m sprint whereas the CD have presented the lowest performance (4.41 ± 0.2s). This latter was opposite to the results reported by Gil et al. (12) who observed the best values in agility, velocity and power in forwards. From these results, it appears that the tactics employed by these various teams may differ, especially for the forwards who seem to prioritize weight over speed. Tactic used by coach and staff surely influence the choice of anthropometric and physical profile to occupy this strategic position (36, 38).

The specific soccer endurance assessed by the YYIRT1 increased significantly during this year of training. While our initial values were lower than those observed by Wong et al. (19) in U-14 Chinese elite soccer players (1933 ± 787.5m), the final values for our players were significantly higher, showing a 28.8% increase. Moreover, there was a significant increase in YYIRT values. These enhancements could be primarily explained by the lower physical potential of the players at the beginning of the season. In fact, the tests were set just after their integration into the structure and just after a holiday break in training which was accompanied by a diminution of volume and intensity of training and also a lack of nutritional monitoring. These data highlight the deleterious effects of summer break on physical fitness (39). Furthermore, the observed could be explained by the process of biological development involving the maturity of central and peripheral functions as cardio-respiratory, muscular, hormonal and enzymatic and/or by the training realized in this academy. As training in professional clubs is known to be important to prepare players to a high level of competition (40), it is reasonable to speculate that the training plan was effective in preparing them for elite soccer.

There were also some positional differences in physical performances as reported by Bangsbo et al. (41). If there were no differences in T1 between our groups, the YYIRT performances in T2 of outfield players were significantly higher. Time spent on the field whatever in training sessions or in official game may had induced specific adaptations allowing them to be more able to repeat high intensity exercise.

In accordance with Gil et al. (12), we observed also that FW have the best endurance capacity jugged by the performance in YYIRT despite of their percentage of fat mass. Nevertheless, these results were at the opposite of those found by Wong et al. (15) who have reported greater values for MF than FW. These results were also in contradiction with the scientific literature according to the elite adult soccer players (42), where MF have the best endurance capacity or performed the greatest total distance and total distance in high-intensity covered in match play (27). These differences could be explained by the training program proposed this year and/or the relative inexperience of training and match of our young players compared to elite adult soccer players.

5. Limitation of the study

This study, while providing insights, was subject to several limitations. A notable shortcoming was the absence of a control group, making it difficult to distinguish the effects of natural maturation from the training program's impact. The focus on Tunisian U-16 elite soccer players also limits the generalizability of the findings, as different countries and academies may have varied training methods. The complexity of accurately categorizing players by their positions presented another challenge, highlighting the need for more nuanced approaches in positional analysis. Furthermore, the study did not consider psychological factors, which play a crucial role in the development of young athletes.

Alongside physical abilities, it is critical to account for elements linked to an athlete's psychological state during season. Within the complex framework of sports performance, mental and psychological competencies emerge as a crucial component for achieving athletic excellence (43, 44).

6. Conclusion

This study observed significant increases in anthropometric and physical fitness parameters during one season of elite training in young Tunisian soccer players. However, accurately distinguishing players based on playing position proved challenging. Nonetheless, differences in activity profiles during matches likely contribute to physical and physiological disparities. Customized training based on individual abilities and playing positions may enhance match-play performance and facilitate the establishment of accurate reference profiles. Further research is needed to better understand differentiation processes according to playing positions.

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Ethical Approval and Consent to Participate

This study was approved by the Ethics Committee of Farhat Hached Hospital, Sousse, Tunisia under the reference number (Ref: FHHEC21052020).

Consent for Publication

Not applicable.

Competing Interests

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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Authors' Contributions

M.A.H and K.B.A: conception and design.
H.G and M.T: analysis and interpretation of the data.
M.A.H, R.M, and M.M.B: drafting of the paper.
M.A.H, K.B.A, H.G, R.M, M.T, M. M.B, and L.B.I: investigation.
L.B.I: revising it critically for intellectual content.
All authors gave their final approval to the version that will be published.

Declaration

None.

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